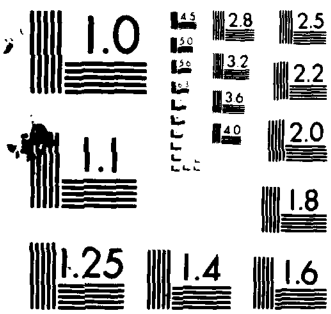
AD-A113 094 CENTER FOR NAVAL ANALYSES ALEXANDRIA VA NAVAL STUDIE--ETC F/G 5/9
THE INFLUENCE OF NON-PECUNIARY FACTORS ON LABOR SUPPLY.(U)
DEC 81 J T WARNER, M S GOLDBERG N00014-76-C-0001
UNCLASSIFIED CNA-PP-337 NL

END
DATE
FILMED
4 82
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

PROFESSIONAL PAPER 337 / December 1981

AD A113094

THE INFLUENCE OF NON-PECUNIARY FACTORS ON LABOR SUPPLY

John T. Warner
Matthew S. Goldberg

N00014-76-C-0001

CNA

CENTER FOR NAVAL ANALYSES

PROFESSIONAL PAPER 337 / December 1981

THE INFLUENCE OF NON-PECUNIARY FACTORS ON LABOR SUPPLY

John T. Warner
Matthew S. Goldberg

Naval Studies Group

CENTER FOR NAVAL ANALYSES

2000 North Beauregard Street, Alexandria, Virginia 22311

The Influence Of Non-Pecuniary Factors On Labor Supply:

The Case Of Navy Enlisted Personnel

By

John T. Warner

And

Matthew S. Goldberg*

*Clemson University and The Center for Naval Analyses, respectively.
The work reported herein was funded by the Office of the Assistant Secretary of Defense for Manpower, Reserve Affairs, and Logistics. The authors express their extreme gratitude for the expert research assistance of Bruce Simon and Michael Hager. They also wish to thank Ms. Jane Crostser of the Defense Manpower Data Center for assembling the massive data file utilized in this study. They also wish to thank Bruce Yandle and George Borjas for comments on a previous draft.

1. Introduction

Economists have long been interested in the effects of non-pecuniary elements on the equilibrium prices that prevail in output and factor markets.[1] In particular, non-pecuniary elements play a large role in the determination of equilibrium wage rates and the self-selection of individuals with dispersed tastes into various occupations. Although this problem has been analyzed with some success in the civilian sector of the economy,[2] most of the labor supply studies have been primarily concerned with estimation of wage elasticities rather than estimation of the effects of non-pecuniary elements. Further, the interaction between the wage elasticities and non-pecuniary elements has been neglected.

The military sector provides a unique opportunity to study the interaction between pecuniary and non-pecuniary elements. In particular, sea duty is the major non-pecuniary element influencing the reenlistment decisions of Navy enlisted personnel. The pecuniary aspects of the Navy reenlistment decision have been examined at some length,[3] but our paper is the first to assess the effects of sea duty on both the location and the elasticity of the reenlistment supply curve. Previous studies have been unable to address this question since they used cross-section

---

1. For theoretical discussions of pricing in differentiated markets, see Rosen(1974), Sattinger(1977), and Goldberg(forthcoming).

2. See Thaler and Rosen(1974), for example.

3. See Grubert(1970), Kleinman and Shughart(1974), and Enns(1977).

data, and thus estimated only a single "average" pay response. By contrast, our study uses time series data on each of several Navy occupational groups, so that we may estimate a different pay response within each group. Our results support the hypothesis that the pay response is inversely related to the incidence of sea duty. That is, larger pay increases are required to elicit a given reenlistment response in those occupations where the incidence of sea duty is high. This finding has a direct application to the management of the Navy's reenlistment bonus program, as well as to other compensation issues such as the optimal amount of sea pay.

In the next section we discuss in somewhat more detail our data, the Navy occupational structure, the variation across occupations in the amount of sea duty, and the unique features of the military compensation system. The second section develops an economic model of the reenlistment decision. The third section shows our empirical results. Finally, a brief summary concludes the paper.

2. Preliminaries

The Data

The data for this study were provided by the Defense Manpower Data Center (DMDC). DMDC assembled for us a data file on all Navy enlisted personnel who made a first-term reenlistment decision between FY1974 and FY1978.[4] Our sample contains

4. Navy enlisted personnel may reenlist for a period of three to six years. First-term reenlistments are those that occur between the third and sixth years of service.

background and military history data on about 220,000 individuals.

The Navy has over 70 enlisted occupations, called ratings. These range from very high skilled electronics technicians (ET) to relatively unskilled Boatswain's Mates (BM). For purposes of this analysis, we divided the Navy into 16 occupational areas. Each area is an aggregation of ratings which are similar in terms of training, job requirements, and working conditions.

These occupational areas are listed in Table 1 along with the sample size and the proportion of careerists in sea duty in each area. (Appendix A contains a list of the ratings included in each area.) As the table indicates, the extent of sea duty varies considerably by occupational area, being the highest in such groups as Ship Maintenance and Marine Engineering and lowest in Health Care and Cryptology.

Sample Reenlistment Statistics

Table 2 displays first-term reenlistment rates by fiscal year for the 16 occupation groups. The data reveal a significant increase in reenlistment rates between FY1974 and FY1975, clearly due to the large increase in civilian unemployment that occured during that period. Between FY1975 and FY1978, rates generally declined. As the data in table 3 below on reenlistment bonuses indicate, much of this decline is explained by a reduction in bonuses. Generally speaking, the data in Table 2 illustrate an inverse relationship between the extent of sea duty and reenlistment rates.

TABLE 1: NAVY ENLISTED OCCUPATIONAL AREAS

		Sample Size	% of Total	Percent of Careerists in Sea Duty
1.	Ship Maintenance	10,956	4.96	69.8
2.	Health Care	16,624	7.54	26.9
3.	Logistics	19,637	8.90	50.4
4.	Marine Engineering	35,557	16.10	69.7
5.	Weapons Systems/Control	12,781	5.79	63.2
6.	Aviation Maintenance	37,889	17.18	30.9
7.	Construction	6,752	3.06	46.3
8.	Administration	18,055	8.18	29.1
9.	Ship Operations	5,480	2.48	65.1
10.	Communications/Sensor Systems	17,955	8.14	50.7
11.	Aviation Ground Support	8,004	3.63	45.6
12.	Data Systems	3,170	1.44	41.6
13.	General Seamanship	9,790	4.44	61.8
14.	Ordnance	7,858	3.56	59.2
15.	Cryptology	6,264	2.84	6.3
16.	Media	3,794	1.72	27.2
	Total	220,566		

TABLE 2

FIRST-TERM REENLISTMENT RATES BY OCCUPATION GROUP, FY 1974-78

	1974	1975	1976	1977	1978
1.Ship Maintenance	17.4	32.6	21.8	20.9	18.7
2.Health Care	20.5	28.3	21.7	20.6	20.0
3.Logistics	15.6	41.5	31.3	31.7	29.4
4.Marine Engineering	27.6	33.6	24.8	23.3	21.3
5.Weapons Systems/Control	28.3	21.4	25.2	28.3	24.1
6.Aviation Maintenance	24.4	34.8	28.1	25.3	22.5
7.Construction	28.0	31.6	15.5	13.8	13.3
8.Administration	23.8	33.6	27.5	31.5	29.5
9.Ship Operations	12.0	23.0	20.8	19.2	17.7
10.Communications/Sensor Systems	19.5	23.8	30.1	24.0	23.3
11.Aviation Ground Support	15.6	27.3	22.9	28.3	24.2
12.Data Systems	28.5	21.1	16.3	20.6	27.2
13.General Seamanship	18.7	30.5	24.8	35.4	22.3
14.Ordnance	18.9	32.4	29.1	38.7	36.0
15.Crypotology	13.2	19.2	26.6	32.5	33.9
16.Media	28.6	21.4	17.3	18.5	15.7
Total	21.9	30.5	25.6	25.5	23.6

The Military Compensation System

The military compensation system is characterized by several unique features. First, there is very little flexibility in the compensation system. The basic measure of military pay, called Regular Military Compensation (RMC), is received by everyone with the same paygrade and length of service (LOS). The Selective Reenlistment Bonus (SRB) is the only significant occupationally variable pay.[5] The SRB is the product of (1) monthly basic pay at the time of reenlistment, (2) an SRB multiple ranging from 1 to 6, and (3) years of reenlistment commitment, ranging from 3 to 6. Prior to FY1980, bonuses ranged up to a maximum of $15000 and were paid in annual installments over the length of reenlistment. Since then, they have been paid in lump-sum, and the maximum has been raised to $20000.

Average bonus multiples for each occupational area are shown in Table 3. There is a substantial amount of within and across-occupational variation in SRB multiples during our sample period. SRB multiples are usually changed by the Navy when career manning levels fall short of or exceed desired levels, usually at the start of each fiscal year. The general decline in multiples after FY1975 was due in part to a reduction in the size of the Navy enlisted force, but also to political pressures to reduce military manpower costs. This variation in SRB multiples pro-

---

5. RMC is comprised of basic pay, allowances for food and quarters, and a "tax advantange" owing to the non-taxability of allowances. Aside from bonuses, other occupationally variable pays include sea and submarine pay. Yet, prior to FY1980, these pays were trivial, amounting to less than 2 percent of RMC.

TABLE 3

AVERAGE FIRST-TERM BONUS MULTIPLE BY OCCUPATION GROUP, FY 1974-78

	1974	1975	1976	1977	1978
1.Ship Maintenance	4.8	4.7	3.6	3.6	2.4
2.Health Care	2.0	1.0	1.0	1.0	.7
3.Logistics	1.0	1.5	1.0	1.3	1.5
4.Marine Engineering	4.6	4.6	3.6	4.3	3.8
5.Weapons Systems/Control	3.2	1.7	1.9	2.7	2.7
6.Aviation Maintenance	3.0	2.4	1.5	1.6	1.5
7.Construction	3.0	2.7	1.0	1.0	.8
8.Administration	1.9	1.6	1.0	1.0	.8
9.Ship Operations	4.7	4.6	3.8	3.3	2.7
10.Communications/Sensor Systems	5.0	2.6	2.5	2.2	2.2
11.Aviation Ground Support	1.9	1.2	1.4	2.1	1.6
12.Data Systems	3.0	1.2	1.2	1.6	2.6
13.General Seamanship	2.5	2.4	1.7	2.5	1.5
14.Ordnance	2.9	3.7	3.7	4.3	4.1
15.Cryptology	2.7	1.7	1.6	1.9	1.9
16.Media	3.4	1.5	1.0	1.0	.8

vides us with substantial variation in military pay during our sample period. Importantly, the SRB changes that occured during this period were due to exogenous factors, obviating the need to model a potential link running from reenlistment rates to bonus multiples as well as the link running from bonus multiples to reenlistment rates.

The last unique feature of the military compensation system is the retirement system, which now vests individuals in an immediate, lifetime inflation-protected annuity after 20 years of service. This system casts a long shadow on reenlistment decisions prior to 20 years of service. Yet, whether a change in the system would have any effect on first-term reenlistment decisions is a subject of analysis below.

3. An Economic Model of Reenlistment Behavior

We begin the development of our theoretical model by considering an individual at the end of his first term of military service. This individual faces a problem of deciding to remain for one or more terms of additional service. That is, he faces a problem of decision-making over multiple time horizons. Will he stay for at least one more term or will he leave immediately? To address this question, we define the following:

M_j=the individual's expected military pay in each future year of service.

j =1....n^* ,where n^* equals the maximum allowable additional years of service.

R_{jn} =yearly retired pay the individual will

receive after n more years of service, $j=n+1...T$, where T equals life expectancy.

W_{j0} =the future civilian earnings stream the individual expects to receive if he leaves immediately, $j=1...T$.

W_{jn} =the future civilian earnings stream the individual if he leaves after n more years of service.

p =the individual's yearly rate of time preference.

$d^j = (1/(1+p))^j$ =the present value at the time of the reenlistment decision of a dollar received j years in the future, $j=1...T$.

Our individual must evaluate the returns to staying and the return to leaving over n possible future time horizons.[6] We define the cost of leaving over each of these horizons, C_n, as the difference between the present value of the income stream from staying n more years and then leaving and the income stream from leaving immediately. Thus, C_n equals

$$\sum_{j=1}^{n} M_j d^j + \sum_{j=n+1}^{T} (R_{jn} + W_{jn})\, d^j - \sum_{j=1}^{T} W_{j0} d^j$$

---

6. Our model is similar to the model of occupational choice in the civilian sector discussed by Boskin(1974). The difference is that the individual in Boskin's model makes a once-and-for-all decision, whereas the individual in our model reevaluates his decision at the end of each term of enlistment. A related model of sequential decision-making is found in Gotz and McCall(1980).

The first two summations express the present value of the income stream from staying n more terms and then leaving, while the right hand summation is the present value of the income stream from leaving immediately. In principle, the income stream from leaving immediately includes already vested retirement benefits, although there is currently no such vesting for first-term decision-makers.

Will the individual stay or leave? To answer this, we introduce a yearly "distaste for service" factor, denoted δ. This factor is the yearly differential between military and civilian life that is required to make the individual indifferent between military and civilian life. It is a measure of the individual's net preference for civilian life. A positive value of δ means that the individual prefers the non-pecuniary aspects of civilian life to the non-pecuniary aspects of military life. We assume that δ is a constant over all prospective future horizons of military service.

If n is the relevant time horizon, then the individual will stay if $C_n > \sum_{j=1}^{n} \delta d^j$, or if $A_n > \delta$, where we define $A_n = C_n / \sum_{j=1}^{n} d^j$. That is, the individual will stay only if the cost of leaving exceeds the present value of his net preference for civilian life. The transformation from C_n to A_n reveals that the individual will stay only if his annualized cost of leaving (ACOL), denoted A_n, exceeds his annual net preference for civilian life.[7]

7. In fact, the time horizon that is relevant is endogenous to the individual's decision-making process. In Appendix B, we demonstrate that the relevant value of n is the one for which A is maximized over the set $n=1,\ldots,n^*$. Empirically, the relevant

Relating ACOL to the Reenlistment Rate

The reenlistment rate r is the proportion of individuals for whom $A_n > \delta$. We assume that δ is distributed normally among the cohort of first-term decision-makers with mean μ

and standard deviation σ. Thus, the reenlistment rate may be written as

$$r = P(A_n > \delta) = \int_{-\infty}^{\frac{A_n - \mu}{\sigma}} N(0,1)dz$$

where N(0,1) denotes a standard normal density and $z=(\delta - \mu)/\sigma$. The reenlistment function may be rewritten as

$$r = P(A_n > \delta) = \int_{-\infty}^{\beta_0 + \beta_1 A_n} N(0,1)dz$$

where $\beta_0 = -\frac{\mu}{\sigma}$ and $\beta_1 = 1/\sigma$, a specification which allows the use of probit analysis to estimate the parameters β_0 and β_1. Note that the effect on r of changes in military pay varies inversely with σ.

The Effect of Sea Duty on Reenlistments

We now explore the potential effect of sea duty on reenlistment supply. We examine the effect of sea duty on both the slope and location of the supply curve. Our analysis suggests that more sea duty serves to both reduce the elasticity of the supply curve and to shift it leftward.

---

time horizon for the first-term reenlistment decision turns out

To analyze these effects, suppose that δ_1 is the distaste factor associated with sea duty and δ_2 is the distaste factor accociated with shore duty. Let π be the proportion of time the individual expects to spend in sea duty. Then the individual's distaste for service can be written as a weighted average of δ_1 and δ_2

$\delta = \pi\delta_1 + (1-\pi)\delta_2$. We assume that δ_1 and δ_2 are joint normal with mean vector $(\mu_1 \quad \mu_2)$, standard deviations $(\sigma_1 \quad \sigma_2)$, and correlation ρ between one's distaste for sea duty and one's distaste for shore duty. While we expect that that this correlation is positive, we think that its value is low. The mean of the distribution of δ is $M = \pi\mu_1 + (1-\pi)\mu_2$, and its variance, σ^2, is $\pi^2\sigma_1^2 + (1-\pi)^2\sigma_2^2 + 2\pi(1-\pi)\rho\sigma_1\sigma_2$.

First consider the effect of sea duty on the slope of the reenlistment supply curve. The effect depends on σ_1 and σ_2 , as well as upon π and ρ . Recall that in the probit model the slope parameter β_1 equals $1/\sigma$. Therefore, as σ^2 increases, the slope (and elasticity) of the supply curve diminish. Differentiating σ^2 with respect to π, we find that

$\partial\sigma^2/\partial\pi = 2(\pi\sigma_1^2 - (1-\pi)\sigma_2^2 + (1-2\pi)\rho\sigma_1\sigma_2)$. An increase in π will lower β_1 if $\partial\sigma^2/\partial\pi > 0$. The final term in this expression will approach 0 as π approaches .5 or as ρ approaches 0. Ignoring this term, the sign of $\partial\sigma^2/\partial\pi$ will be the same as the sign of $\frac{\pi}{1-\pi} - \frac{\sigma_2^2}{\sigma_1^2}$. To evaluate this, note that π exceeds .5 for most ratings. Also, it is plausible that there is more dispersion in distastes for

---

to be that of a 4 year reenlistment.

sea duty than in distastes for shore duty, that is, $\sigma_1^2 > \sigma_2^2$. It therefore seems reasonable to hypothesize that $\partial\sigma^2/\partial\pi > 0$, hence increases in π serve to reduce β_1 .

Next consider the effect of sea duty on the location of the supply curve. Recalling that $\mu = \pi\mu_1 + (1-\pi)\mu_2$ and that the constant term in the probit supply equation is $-\mu/\sigma$, the reenlistment supply equation may be written as

$$r = \int_{-\infty}^{\beta_0 + \beta_1 A_n + \beta_2\pi} N(0,1)\, dz$$

where $\beta_0 = -\mu_2/\sigma$ and $\beta_2 = (\mu_2 - \mu_1)/\sigma$.

Since δ measures the distaste for service and since the distaste is likely to be stronger for sea duty than shore duty, it follows that $\mu_1 > \mu_2$. Hence β_2 is negative, and an increase in π serves to reduce r.

4. Empirical Analysis

Empirical Specification of the Model

Our theoretical model suggests that the probability of reenlisting is a function of the annualized cost of leaving. Based on our theoretical model, ACOL over any time horizon n can be written as

$$A_n = \frac{\left(\sum_{j=1}^{n} M_j d^j + \sum_{j=n+1}^{T} R_{jn} d^j\right)}{\sum_{j=1}^{n} d^j} - \frac{\left(\sum_{j=1}^{T} W_{j0} d^j - \sum_{j=n+1}^{T} W_{jn} d^j\right)}{\sum_{j=1}^{n} d^j}$$

The first right-hand side term is the annualized value of military pay plus retirement, the sum of which we label $\bar{M}_n$. The second right-hand side term is the annualized value of civilian earnings, accounting for the fact that n more periods of service may affect the person's civilian earnings capacity. We label this $\bar{W}_n$. If the stream W_{jn} is the same as the last T-n elements of the stream W_{jo}, then additional military service has no net human capital effect and $\bar{W}_n$ will just be the annualized value of the first n elements of W_{j0} . If because of the specific nature of much military training, additional service detracts from one's civilian earnings capacity, then W_{jn} will lie below the last T-n elements of W_{jo} . $\bar{W}_n$ will thus reflect the human capital loss due to further military service. Evidence on the human capital effect of military service is limited.[8]

From this, one specification of the model would be to compute $\bar{M}_n$ and $\bar{W}_n$ and enter the difference $A_n = \bar{M}_n - \bar{W}_n$ as the pay variable in the estimation procedure. External estimates of W_{j0} for different groups of personnel are available in Ross and Warner(1976). They estimated post-service earnings profiles for a cohort of personnel who left after one term of service in FY 1969. Earnings profiles were found to vary significantly by race, education level, mental group as measured from military entry test scores, and military occupation group. For personnel dimensioned by these various attributes, these estimated earnings functions were used to predict their earnings profiles from leaving after

8. For some evidence, see Cooper(1981), Raduchel, et. al.(1978), and Ross and Warner(1976).

the first term. An implied assumption in our procedure is that there is no net human capital effect of continued military service. Since the time horizon n in our calculation of A_n for each person is only the period of reenlistment, this assumption seems innocuous.

The main disadvantage of this approach is that estimates of A_n will be biased to the extent that there is measurement error in $\bar{W}_n$. On the other hand, this procedure has the advantage that the variable A_n will capture variation across individuals in $\bar{W}_n$ as well as $\bar{M}_n$. Thus, even the occupation groups where there was no significant variation in $\bar{M}_n$ during the sample period, there will be enough variation in A_n to obtain a meaningful estimate of β_1.

Instead of calculating A_n for each individual from external estimates of $\bar{W}_n$, an alternative approach is as follows. Suppose that $\bar{W}_n$ is equal to

$$\alpha_0 + \sum_{i=1}^{k} \alpha_i x_i$$

where the x's represent variables for education level, mental group, and race. Then A_n may be written as $\bar{M}_n - \alpha_0 - \sum_{i=1}^{k} \alpha_i x_i$

and the reenlistment equation may be written as

$$r = \int_{-\infty}^{(\beta_0 - \beta_1\alpha_0) + \beta_1 \bar{M}_n - \sum_{i=1}^{k} \beta_1 \alpha_i x_i} N(0,1)\,dz \quad .$$

This is a reduced form equation in $\bar{M}_n$ and the determinants of $\bar{W}_n$. The primary advantage of this method is that the esti-

mates of β_1 are less likely to be biased than in the first specification, since there will presumably be less measurement error in $\bar{M}_n$ than $\bar{W}_n$. (We can measure military earnings quite accurately.) Although bias in the estimation of β_1 is less likely, the primary disadvantage of this procedure is that it does not utilize all of the available variation across individuals in A_n. Again, in occupation groups where the variation in $\bar{M}_n$ is low, this specification will not yield meaningful estimates of β_1.

Reenlistment equations were estimated using both specifications. In general, both specifications tended to yield the same pattern of results. Occupation groups that had a high (low) estimate of by one specification had a high (low) estimate by the other specification. The weighted correlation between the estimates for the different groups, where the weights are the per centage of the sample in each occupation group, is +.72. Overall, we prefer the results from the first specification for two reasons. First, the estimates of β_1 by the first specification in general were larger and more in line with estimates from previous studies. Second, the dispersion across occupation groups in the estimates was smaller, and the pattern of estimates appeared more consistent. Thus, we proceed to present the estimates from the first specification without attempting a detailed comparison between specifications.

Pay Responsiveness of Different Occupation Groups

Table 4 shows the estimates of β_1 for the first specification of the model. Also shown in the table are the estimated pay

TABLE 4

ESTIMATES OF β_1, THE FIRST-TERM PAY ELASTICITY (E), AND THE EFFECT OF A ONE LEVEL INCREASE IN SRB

	β_1	E	Δr
SHIP MAINTENANCE	.000200 (8.02)[a]	2.12	.023
HEALTH CARE	.000265(21.13)	2.91	.033
LOGISTICS	.000325(31.47)	3.25	.055
MARINE ENGINEERING	.000172(14.38)	1.86	.023
WEAPONS SYSTEMS/CONTROL	.000236(17.53)	2.46	.034
AVIATION MAINTENANCE	.000231(32.99)	2.46	.032
CONSTRUCTION	.000288(16.58)	3.42	.026
ADMINISTRATION	.000252 (2.44)	2.44	.042
SHIP OPERATIONS	.000026 (1.06)	----	----
COMMUNICATIONS	.000177(13.73)	1.86	.025
AVIATION GROUND SUPPORT	.000236(15.60)	2.46	.034
DATA SYSTEMS	.000241 (9.16)	2.41	.038
GENERAL SEAMANSHIP	.000216(17.38)	2.30	.030
ORDNANCE	.000121 (6.38)	1.06	.022
CRYPTOLOGY	.000285(14.91)	2.59	.051
MEDIA	.000172 (7.43)	1.99	.018
WEIGHTED AVERAGE	.000211	2.35	.032

[a] t values in parenetheses.

elasticity (percent increase in r for a one percent increase in second-term military pay) and the estimated effect on r of a one level increase in SRB.

The first conclusion we reach is that variation in A_n explains much of the variation in the probability of reenlisting. With one exception, the estimates of β_1 are all positive and highly statistically significant. The weighted average pay elasticity calculated from our estimates of β_1, 2.35, is quite consistent with estimates from previous studies. (See Enns(1977, table D-1) for a review.)

The second conclusion we reach is that the estimates of do indeed vary with the extent of sea duty. Ignoring the statistically insignificant estimate for the Ship Operations group, the weighted correlation between β_1 and the percentage of careerists in sea duty is -.49. This correlation is statistically significant at the .06 level. While the correlation is not perfect, it supports the hypothesis that reenlistment supply curves are less elastic in occupations characterized by a high amount of sea duty.

The estimated effect of a one level increase in the SRB is shown in the righthand column of table 4. These calculations were made using FY1978 reenlistment rate as the base. Since the reenlistment supply function is nonlinear, the estimated Δr depends on the level of r. We estimate that, beginning with 1978 values of r, a one level bonus increase will raise r by between .018 and .055, with a weighted average estimate of .032. That

is, on the average, each one multiple increase will generate 3.2 reenlistments per 100 persons eligible to reenlist.

How well do these estimates predict the effect of bonus changes? At the aggregate level, they predict quite well. Between 1978 and 1979, 53 Navy ratings suffered a reduction in reenlistment bonuses, while no rating experienced an increase.[9] Between 1978 and 1979 reenlistment rates fell, but they fell by .045 more in those ratings experiencing a bonus reduction than in those ratings experiencing no change. Between 1979 and 1980, 8 ratings experienced a bonus reduction. The reenlistment rate in these ratings fell by .030 relative to the 1979-80 change in those ratings experiencing no bonus change. Our average estimate of the effect of a bonus change, .032, is bounded by these 1978-79 and 1979-80 average changes. The data are not yet sufficient to validate our predictions for individual occupation groups, but we will do so as the data do become available.

The Impact of Other Factors

In the first specification of the model, other variables included were the individual's marital status and the civilian unemployment rate at the time of reenlistment. Married individuals were found to reenlist at a higher rate than single persons, and this effect was quite stable across occupation groups. These

---

9. These bonus reductions came as a result of elimination of the regular reenlistment bonus (RRB) program. This program, which gave a level one bonus to all reenlistees, was eliminated in 1974, but a "save pay" provision awarded a level one bonus to all reenlistees in non-SRB ratings who entered service prior to 30 june 1974. Most of these individuals reached the end of their first term of service by June 1978.

results are indicative of the fact that military non-pecuniary benefits, principally medical benefits, are of greater value to married persons than single persons. The estimated impact of civilian unemployment was less stable, being positive and statistically significant in only 8 of 16 equations. Of the significant estimates, the average elasticity between r and civilian unemployment was +.5.

The Location Effect of Sea Duty

Our theory suggests that sea duty serves to shift the supply curve as well as alter its slope. Because of the lack of variation in the extent of sea duty within occupation groups, we could not test for a location effect in our time series analysis. We can do so, however, in a cross-section analysis. To do this, we estimated a probit equation utilizing data on all of the first-term personnel making reenlistment decisions in FY1979. The sea duty variable included in this analysis is the proportion of personnel in the individual's rating who are in sea duty in the 4 LOS cells following the individual's LOS cell at the time of his decision. This proportion is a proxy for individual's expected proportion of sea time during another term of enlistment. Other variables in this analysis include various background variables previously used, the annualized value of military pay over the horizon of a reenlistment, and military occupation group dummies (to standardize for differences in civilian opportunities due to differences in military training).

Table 5 reports the estimated effect of sea duty. The estimated effect of sea duty is negative and highly statistically significant. At the sample means, we estimate that a 10 percent increase in the extent of sea time during the second term of service will reduce r by .016. The elasticity of r with respect to sea duty ($\%\Delta r/\%\Delta s$) is -.34. Rating groups for which the extent of sea time during the second-term exceeds 70 percent will have a reenlistment rate that is around 5 percentage points lower than rating groups where the extent of sea time is between 40 and 50 percent.

While sea duty has a negative effect on the first-term reenlistment rate, it appears that its adverse effects are readily controlled by bonuses. Even in occupation groups where the retention effect of bonuses is low, the estimated effect of a one multiple SRB change outweighs the effect of a 10 percent increase in the extent of second-term sea duty.

These results have some important policy implications. The Navy's first priority is to man ships as close to "requirements" as possible. Recently some ships have been tied up due to lack of personnel to man them. At least in rating groups where the extent of sea duty is not already very high, our results suggest that the Navy may increase ship manning more cheaply by raising bonsues and increasing the extent of sea time than by holding constant (or lowering) sea time and raising the total size of the Navy.

5. Conclusions

TABLE 5

ESTIMATED EFFECT OF SEA DUTY

Coefficient And t Value	Effect Of A 10 Percent Increase In Sea Time During Second-Term	Elasticity
-.765 (15.21)	-.016	-.34

This paper has developed and estimated a model of the first-term reenlistment decisions of Navy enlisted personnel. Our results suggest that sea duty exerts a significant influence on the reenlistment supply functions of Navy enlisted personnel. Additional sea duty serves both to reduce the elasticity of the reenlistment supply function and to shift it leftward. Our results have significant implications for the management of the Navy's reenlistment bonus program as well as for other compensation and personnel policies.

References

1. Boskin, Michael, "A Conditional Logit Model of Occupational Choice," Journal of Political Economy, Vol. 82, March 1974.

2. Cooper, Richard V. L. , Military Retirees' Post-Service Earnings and Employment, R-2493-MRAL, The Rand Corporation, Feb. 1981.

3. Enns, John H., Reenlistment Bonuses: Their Impact on First-Term Retention," R-1935-ARPA, The Rand Corporation, September 1977.

4. Gilman, Harry J., "Determinants of Implicit Discount Rates," unpublished manuscript, The Center for Navy Analyses, Sept. 1976.

5. Goldberg, Matthew, "Discrimination, Nepotism, and Long-run Wage Differentials," Quarterly Journal of Economics, forthcoming.

6. Gotz, Glenn, and John J. McCall, "Estimating Miltiary Personnel Retention Rates: Theory and Statistical Method," R-2541-AF, The Rand Corporation, Santa Monica, Cal., June 1980.

7. Grubert, Harry and Rodney Weiher, "Navy Re-enlistments: The Role of Pay and Draft Pressure", In Volume I of Studies Prepared for the President's Commission on an All-Volunteer Force, U.S. Government Printing Office, Nov. 1970.

8. Kleinman, Samuel D. and William F. Shughart, "The Effects of Reenlistment Bonuses," CRC 269, The Center for Naval Analyses, Sept. 1974.

9. Raduchel, William, et. al., "Post-Retirement Income and Earnings of Recently Retired Military Personnel: An Analysis, "in Supplementary Papers for The President's Commission on Military Compensation,U.S. Government Printing Office, April 1978.

10. Rosen, Sherwin, "Hedonic Prices and Implicit Markets: Product Differentialism in Pure Competition," Journal of Political Economy, Vol. 82, January 1974.

11. Ross, Sue Goetz and John T. Warner, "Comparisons of Military and Veter Compensation," CRC 306, The Center for Naval Analyses, Dec. 1976.

12. Sattinger, Michael, "Compensating Wage Differences," Journal of Economic Theory, Vol. 16, 1977, pp. 496-503.

13. Thaler, Richard, and Sherwin Rosen, "The Value of Saving a Life," in Household Production and Consumption,, ed. Nestor Terleckyj, N.B.E.R., 1975.

14. Warner, John T., "Alternative Military Retirement Systems: Their Effects on Enlisted Retention," CRC 376, The Center for Naval Analyses, Sept. 1979.

15. Warner, John T., "Military Compensation and Retention: An Analyses of Alternative Models and A Simulation of A New Retention Model," CRC 436, The Center for Naval Analyses, Oct., 1981.

Appendix A

This appendix shows the two-letter Navy ratings in each of the 16 occupation groups. in our analysis. Some of the two-letter ratings listed below may be broken down into detailed three-letter ratings, although that is not done here.

1. Ship Maintenance: Hull Technician (HT), Machinery Repairman (MR), Molder (ML), Patternmaker (PM), Instrument Man (IM), Optical Man (OM)
2. Health Care: Hospital Corpsman (HM), Dental Technician (DT)
3. Logistics: Storekeeper (SK), Aviation Storekeeper (AK), Disbursing Clerk (DK), Mess Management Specialist (MS)
4. Marine Engineerning: Machinist Mate (MM), Boiler Technician (BT), Engine man (EN), Electrician's Mate (EM), Interior Communications Electrician (IC)
5. Weapons Systems/Control: Electronics Technician (ET), Fire Control Technician (FT)
6. Aviation Maintenance: Aviation Electronics Technician (AT), Aviation Electrician (AE), Aviation Machinist (AD), Aviation Ordnance Man (AO), Aviation Mechanic (AM), Air Traffic Controller (AC), Aviation ASW Technician (AX), Aviation Fire Control Tech. (AQ), Avionics Technician (AV)
7. Construction: Builder (BU), Construction Electrician (CE), Construction man (CN), Engineering Aide (EA), Equipment Operator (EO), Steelworker (SW), Utilitiesman (UT),
8. Administration: Legalman (LM), Navy Councilor (NC), Personnel Man (PN), Postal Clerk (PC), Yeoman (YM)
9. Ship Operations: Operations Specialist (OS), Quartermaster (QM)
10. Communications/Sensor Systems: Radarman (RM), Electronic Warfare Technician, (EW), Sonar Technician (ST), Ocean Systems Technician (OT), Aviation Electronic Warfare Technican (AW)
11. Aviation Ground Support: Aviation Boatswain's Mate (AB), Aviation Support Technician (AS), Parachute Rigger (PR)
12. Data Systems: Data Systems Technician (DS), Data Processor (DP)
13. General Seamanship: Boatswain's Mate (BM), Signalman (SM)
14. Ordanance: Gunner's Mate (GM), Mineman (MN), Missile Technician (MT), Torpedoman (TM)
15. Cryptology: Cryptologist (CT), Intelligence Specialist (IS)
16. Media: Photographer (PH), Journalist (JO), Librarian (LI), Lithographer (LI), Musician (MU)

Appendix B

Derivation of the Time Horizon Relevant for Reenlistment Decisions

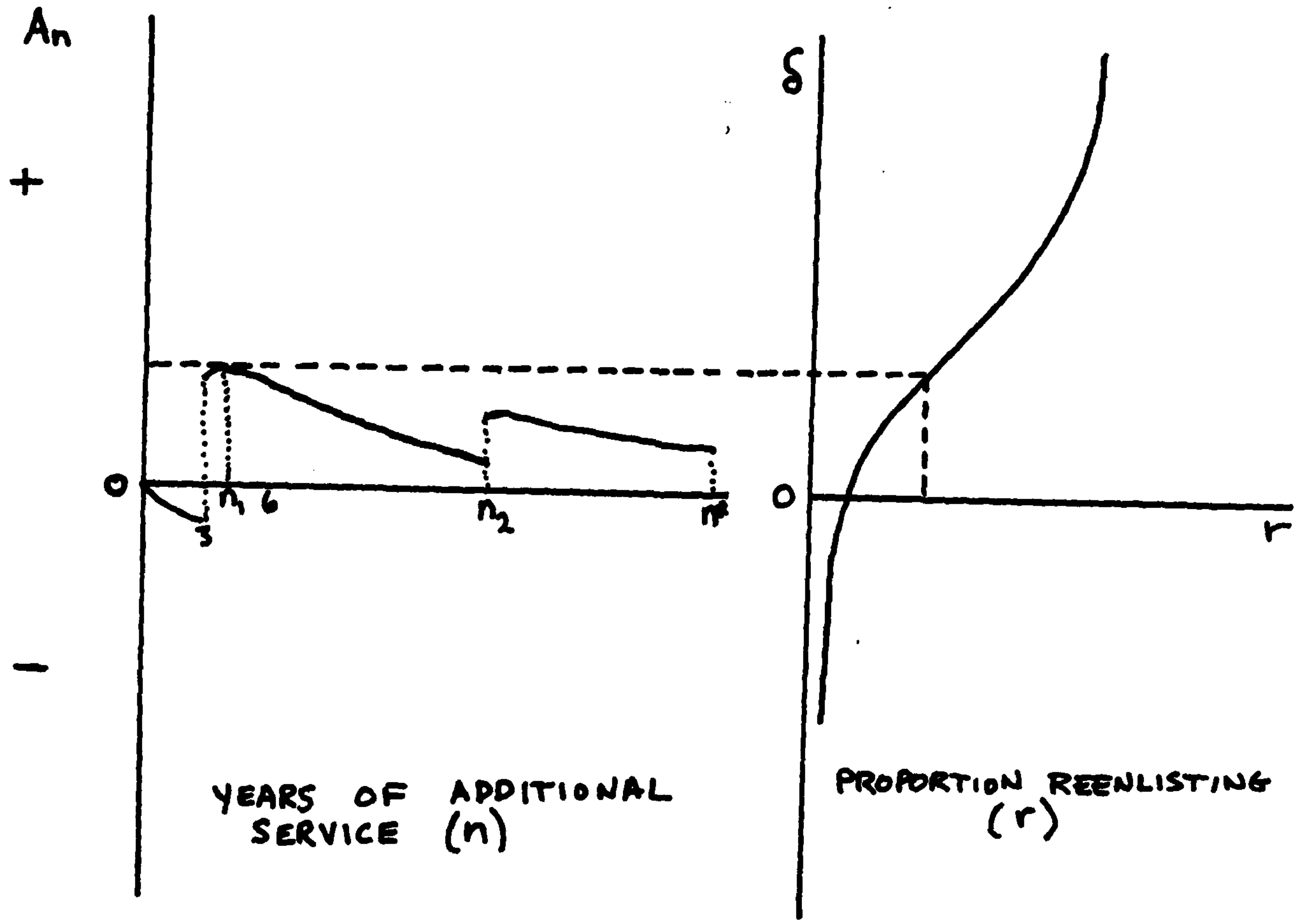
The individual prefers a strategy of staying n more years and then leaving to one of leaving immediately if and only if $C_n > \sum_{j=1}^{n} \delta d^j$, or $A_n > \delta$, where $A_n = C_n / \sum_{j=1}^{n} d^j$. The individual will leave if and only if the strategy of leaving immediately is preferred to any strategy that involves staying, or $A_n < \delta$ for all $n = 1, \ldots, n^*$. This is equivalent to the condition $\mathrm{Max}\ A_n < \delta$. The individual will stay if and only if this condition is false, or $\mathrm{Max}\ A_n > \delta$. Hence the relevant ACOL value for decision-making is the maximum value over the set $(A_1, \ldots, A_{n^*})$, and the relevant time horizon for computing ACOL is the one over which the ACOL value is maximized.

The left-hand panel of Figure 1 plots a typical pattern of ACOL values over various time horizons for personnel facing a first-term reenlistment decision. The right-hand panel plots values of δ on the vertical axis and the cumulative probability density of δ (i.e., the reenlistment rate r) on the horizontal axis.

Note some interesting features of the first-term reenlistment decision. Because of the fact that bonuses are concentrated at the first-term reenlistment point and because first-term personnel appear to exhibit high discount rates,[10] the maximum ACOL value is usually found within the period of a reenlistment (horizon n_1 in Figure 1). ACOL values decline between the length of a

---

10. The interested reader is referred to Gilman(1976). From Gilman's results, we predict that first-term personnel have real annual discount rates between 15 and 20 percent.



A_n
+
0
−
n_1 6
3
n_2
n^*
YEARS OF ADDITIONAL SERVICE (n)
δ
0
r
PROPORTION REENLISTING (r)

FIGURE 1

first reenlistment and LOS 20, because later bonuses are lower than first-term bonuses and because RMC falls short of civilian earnings after about 8 years of service. Because of retirement vesting, ACOL values rise again at LOS 20. Yet ACOL over this horizon usually does not rise as high as ACOL over the period of a first reenlisment (hence the justification for using ACOL values over the horizon of a reenlistment in the empirical analysis).

A strong implication of the ACOL model is that a simple reduction in 20-year retirement benefits would have no effect on the first-term reenlistment rate, although reenlistment rates at later terms would be affected. For analyses of the effects of recently proposed changes to the military retirement system, see Warner(1979,1981).

CNA PROFESSIONAL PAPERS - 1978 TO PRESENT*

PP 211
Mizrahi, Maurice M., "On Approximating the Circular Coverage Function," 14 pp., Feb 1978, AD A054 429

PP 212
Mangel, Marc, "On Singular Characteristic Initial Value Problems with Unique Solution," 20 pp., Jun 1978, AD A058 535

PP 213
Mangel, Marc, "Fluctuations in Systems with Multiple Steady States. Application to Lanchester Equations," 12 pp., Feb 78 (Presented at the First Annual Workshop on the Information Linkage Between Applied Mathematics and Industry, Naval PG School, Feb 23-25, 1978), AD A071 472

PP 214
Weinland, Robert G., "A Somewhat Different View of The Optimal Naval Posture," 37 pp., Jun 1978 (Presented at the 1976 Convention of the American Political Science Association (APSA/IUS Panel on "Changing Strategic Requirements and Military Posture"), Chicago, Ill., September 2, 1976), AD A056 228

PP 215
Colle, Russell C., "Comments on: Principles of Information Retrieval by Manfred Kochen," 10 pp., Mar 78 (Published as a Letter to the Editor, Journal of Documentation, Vol. 31, No. 4, pages 298-301), December 1975), AD A054 426

PP 216
Colle, Russell C., "Lotka's Frequency Distribution of Scientific Productivity," 18 pp., Feb 1978 (Published in the Journal of the American Society for Information Science, Vol. 28, No. 6, pp. 366-370, November 1977), AD A054 425

PP 217
Colle, Russell C., "Bibliometric Studies of Scientific Productivity," 17 pp., Mar 78 (Presented at the Annual meeting of the American Society for Information Science held in San Francisco, California, October 1976), AD A054 442

PP 218 - Classified

PP 219
Huntzinger, R. LaVar, "Market Analysis with Rational Expectations: Theory and Estimation," 60 pp., Apr 78, AD A054 422

PP 220
Maurer, Donald E., "Diagonalization by Group Matrices," 26 pp., Apr 78, AD A054 443

PP 221
Weinland, Robert G., "Superpower Naval Diplomacy in the October 1973 Arab-Israeli War," 76 pp., Jun 1978 (Published in Seapower in the Mediterranean: Political Utility and Military Constraints, The Washington Papers No. 61, Beverly Hills and London: Sage Publications, 1979) AD A055 564

PP 222
Mizrahi, Maurice M., "Correspondence Rules and Path Integrals," 30 pp., Jun 1978 (Invited paper presented at the CNRS meeting on "Mathematical Problems in Feynman's Path Integrals," Marseille, France, May 22-26, 1978) (Published in Springer Verlag Lecture Notes in Physics, 106, (1979), 234-253) AD A055 536

PP 223
Mangel, Marc, "Stochastic Mechanics of Moleculeion Molecule Reactions," 21 pp., Jun 1978, AD A056 227

PP 224
Manger, Marc, "Aggregation, Bifurcation, and Extinction in Exploited Animal Populations*," 48 pp., Mar 1978, AD A058 536
*Portions of this work were started at the Institute of Applied Mathematics and Statistics, University of British Columbia, Vancouver, B.C., Canada

PP 225
Mangel, Marc, "Oscillations, Fluctuations, and the Hopf Bifurcation*," 43 pp., Jun 1978, AD A058 537
*Portions of this work were completed at the Institute of Applied Mathematics and Statistics, University of British Columbia, Vancouver, Canada.

PP 226
Ralston, J. M. and J. W. Mann,* "Temperature and Current Dependence of Degradation in Red-Emitting GaP LEDs," 34 pp., Jun 1978 (Published in Journal of Applied Physics, 50, 3630, May 1979) AD A058 538
*Bell Telephone Laboratories, Inc.

PP 227
Mangel, Marc, "Uniform Treatment of Fluctuations at Critical Points," 50 pp., May 1978, AD A058 539

PP 228
Mangel, Marc, "Relaxation at Critical Points: Deterministic and Stochastic Theory," 54 pp., Jun 1978, AD A058 540

PP 229
Mangel, Marc, "Diffusion Theory of Reaction Rates, I: Formulation and Einstein-Smoluchowski Approximation," 50 pp., Jan 1978, AD A058 541

PP 230
Mangel, Marc, "Diffusion Theory of Reaction Rates, II Ornstein-Uhlenbeck Approximation," 34 pp., Feb 1978, AD A058 542

PP 231
Wilson, Desmond P., Jr., "Naval Projection Forces: The Case for a Responsive MAF," Aug 1978, AD A054 543

PP 232
Jacobson, Louis, "Can Policy Changes Be Made Acceptable to Labor?" Aug 1978 (Submitted for publication in Industrial and Labor Relations Review), AD A061 528

*CNA Professional Papers with an AD number may be obtained from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151. Other papers are available from the Management Information Office, Center for Naval Analyses, 2000 North Beauregard Street, Alexandria, Virginia 22311. An Index of Selected Publications is also available on request. The index includes a Listing of Professional Papers; with abstracts; issued from 1969 to June 1981.

PP 233
Jacobson, Louis, "An Alternative Explanation of the Cyclical Pattern of Quits," 23 pp., Sep 1978

PP 234 - *Revised*
Jondrow, James and Levy, Robert A., "Does Federal Expenditure Displace State and Local Expenditure: The Case of Construction Grants," 25 pp., Oct 1979, AD A061 529

PP 235
Mizrahi, Maurice M., "The *Semiclassical* Expansion of the Anharmonic-Oscillator Propagator," 41 pp., Oct 1978 (Published in Journal of Mathematical Physics 20 (1979) pp. 844-855), AD A061 538

PP 237
Maurer, Donald, "A Matrix Criterion for Normal Integral Bases," 10 pp., Jan 1979 (Published in the Illinois Journal of Mathematics, Vol. 22 (1978), pp. 672-681

PP 238
Utgoff, Kathleen Classen, "Unemployment Insurance and The Employment Rate," 20 pp., Oct 1978 (Presented at the Conference on Economic Indicators and Performance: The Current Dilemma Facing Government and Business Leaders, presented by Indiana University Graduate School of Business). AD A061 527

PP 239
Trost, R. P. and Warner, J. T., "The Effects of Military Occupational Training on Civilian Earnings: An Income Selectivity Approach," 38 pp., Nov 1979k, AD A077 831

PP 240
Powers, Bruce, "Goals of the Center for Naval Analyses," 13 pp., Dec 1978, AD A063 759

PP 241
Mangel, Marc, "Fluctuations at Chemical Instabilities," 24 pp., Dec 1978 (Published in Journal of Chemical Physics, Vol. 69, No. 8, Oct 15, 1978). AD A063 787

PP 242
Simpson, William R., "The Analysis of Dynamically Interactive Systems (Air Combat by the Numbers)," 160 pp., Dec 1978, AD A063 760

PP 243
Simpson, William R., "A Probabilistic Formulation of Murphy Dynamics as Applied to the Analysis of Operational Research Problems," 18 pp., Dec 1978, AD A063 761

PP 244
Sherman, Allan and Horowitz, Stanley A., "Maintenance Costs of Complex Equipment," 20 pp., Dec 1978 (Published By The American Society of Naval Engineers, Naval Engineers Journal, Vol. 91, No. 6, Dec 1979) AD A071 473

PP 245
Simpson, William R., "The Accelerometer Methods of Obtaining Aircraft Performance from Flight Test Data (Dynamic Performance Testing)," 403 pp., Jun 1979, AD A075 226

PP 246
Brechling, Frank, "Layoffs and Unemployment Insurance," 35 pp., Feb 1979 (Presented at the Nber Conference on "Low Income Labor Markets," Chicago, Jun 1978), AD A096 629

PP 248
Thomas, James A., Jr., "The Transport Properties of Dilute Gases in Applied Fields," 183 pp., Mar 1979, AD A096 464

PP 249
Glasser, Kenneth S., "A Secretary Problem with a Random Number of Choices," 23 pp., Mar 1979

PP 250
Mangel, Marc, "Modeling Fluctuations in Macroscopic Systems," 26 pp., Jun 1979

PP 251
Trost, Robert P., "The Estimation and Interpretation of Several Selectivity Models," 37 pp., Jun 1979, AD A075 941

PP 252
Nunn, Walter R., "Position Finding with Prior Knowledge of Covariance Parameters," 5 pp., Jun 1979 (Published in IEEE Transactions on Aerospace & Electronic Systems, Vol. AES-15, No. 3, Mar 1979

PP 253
Glasser, Kenneth S., "The d-Choice Secretary Problem," 32 pp., Jun 1979, AD A075 225

PP 254
Mangel, Marc and Quanbeck, David B., "Integration of a Bivariate Normal Over an Offset Circle," 14 pp., Jun 1979, AD A096 471

PP 255 - Classified, AD B051 441L

PP 256
Maurer, Donald E., "Using Personnel Distribution Models," 27 pp., Feb 1980, AD A082 218

PP 257
Thaler, R., "Discounting and Fiscal Constraints: Why Discounting is Always Right," 10 pp., Aug 1979, AD A075 224

PP 258
Mangel, Marc S. and Thomas, James A., Jr., "Analytical Methods in Search Theory," 86 pp., Nov 1979, AD A077 832

PP 259
Glass, David V.; Hsu, Ih-Ching; Nunn, Walter R., and Perin, David A., "A Class of Commutative Markov Matrices," 17 pp., Nov 1979, AD A077 833

PP 260
Mangel, Marc S. and Cope, Davis K., "Detection Rate and Sweep Width in Visual Search," 14 pp., Nov 1979, AD A077 834

PP 261
Vila, Carlos L.; Zvijac, David J. and Ross, John, "Franck-Condon Theory of Chemical Dynamics. VI. Angular Distributions of Reaction Products," 14 pp., Nov 1979 (Reprinted from Journal Chemical Phys. 70(12), 15 Jun 1979), AD A076 287

PP 262
Peterson, Charles C., "Third World Military Elites in Soviet Perspective," 50 pp., Nov 1979, AD A077 835

PP 263
Robinson, Kathy I., "Using Commercial Tankers and Containerships for Navy Underway Replenishment," 25 pp., Nov 1979, AD A077 836

PP 264
Weinland, Robert G., "The U.S. Navy in the Pacific: Past, Present, and Glimpses of the Future," 31 pp., Nov 1979 (Delivered at the International Symposium on the Sea, sponsored by the International Institute for Strategic Studies, The Brookings Institution and the Yomiuri Shimbun, Tokyo, 16-20 Oct 1978) AD A066 837

PP 265
Weinland, Robert G., "War and Peace in the North: Some Political Implications of the Changing Military Situation in Northern Europe," 18 pp., Nov 1979 (Prepared for presentation to the Conference of the Nordic Balance in Perspective: The Changing Military and Political Situation," Center for Strategic and International Studies, Georgetown University, Jun 15-16, 1978) AD A077 838

PP 266
Utgoff, Kathy Classen, and Brechling, Frank, "Taxes and Inflation," 25 pp., Nov 1979, AD A081 194

PP 267
Trost, Robert P., and Vogel, Robert C., "The Response of State Government Receipts to Economic Fluctuations and the Allocation of Counter-Cyclical Revenue Sharing Grants," 12 pp., Dec 1979 (Reprinted from the Review of Economics and Statistics, Vol. LXI, No. 3, August 1979)

PP 268
Thomason, James S., "Seaport Dependence and Inter-State Cooperation: The Case of Sub-Saharan Africa," 141 pp., Jan 1980, AD A081 193

PP 269
Weiss, Kenneth G., "The Soviet Involvement in the Ogaden War," 42 pp., Jan 1980 (Presented at the Southern Conference on Slavic Studies in October, 1979), AD A082 219

PP 270
Remnek, Richard, "Soviet Policy in the Horn of Africa: The Decision to Intervene," 52 pp., Jan 1980 (To be published in "The Soviet Union in the Third World: Success or Failure," ed. by Robert H. Donaldson, Westview Press, Boulder, Co., Summer 1980), AD A081 195

PP 271
McConnell, James, "Soviet and American Strategic Doctrines: One More Time," 43 pp., Jan 1980, AD A081 192

PP 272
Weiss, Kenneth G., "The Azores in Diplomacy and Strategy, 1940-1945, 46 pp., Mar 1980, AD A085 094

PP 273
Nakada, Michael K., "Labor Supply of Wives with Husbands Employed Either Full Time or Part Time," 39 pp., Mar 1980, AD A082 220

PP 274
Nunn, Walter R., "A Result in the Theory of Spiral Search," 9 pp., Mar 1980

PP 275
Goldberg, Lawrence, "Recruiters Advertising and Navy Enlistments," 34 pp., Mar 1980, AD A082 221

PP 276
Goldberg, Lawrence, "Delaying an Overhaul and Ship's Equipment," 40 pp., May 1980, AD A085 095

PP 277
Mangel, Marc, "Small Fluctuations in Systems with Multiple Limit Cycles," 19 pp., Mar 1980 (Published in SIAM J. Appl. Math., Vol. 38, No. 1, Feb 1980) AD A086 229

PP 278
Mizrahi, Maurice, "A Targeting Problem: Exact vs. Expected-Value Approaches," 23 pp., Apr 1980, AD A085 096

PP 279
Walt, Stephen M., "Causal Inferences and the Use of Force: A Critique of Force Without War," 50 pp., May 1980, AD A085 097

PP 280
Goldberg, Lawrence, "Estimation of the Effects of A Ship's Steaming on the Failure Rate of Its Equipment: An Application of Econometric Analysis," 25 pp., Apr 1980, AD A085 098

PP 281
Mizrahi, Maurice M., "Comment on 'Discretization Problems of Functional Integrals in Phase Space'," 2 pp., May 1980, published in "Physical Review D", Vol. 22 (1980), AD A094 994

PP 283
Dismukes, Bradford, "Expected Demand for the U.S. Navy to Serve as An Instrument of U.S. Foreign Policy: Thinking About Political and Military Environmental Factors," 30 pp., Apr 1980, AD A085 099

PP 284
J. Kellson,* W. Nunn, and U. Sumita,** "The Laguerre Transform," 119 pp., May 1980, AD A085 100
*The Graduate School of Management, University of Rochester and the Center for Naval Analyses
**The Graduate School of Management, University of Rochester

PP 285
Remnek, Richard B., "Superpower Security Interests in the Indian Ocean Area," 26 pp., Jun 1980, AD A087 113

PP 286
Mizrahi, Maurice M., "On the WKB Approximation to the Propagator for Arbitrary Hamiltonians," 25 pp., Aug 1980 (Published in Journal of Math. Phys., 22(1) Jan 1981), AD A091 307

PP 287
Cope, Davis, "Limit Cycle Solutions of Reaction-Diffusion Equations," 35 pp., Jun 1980, AD A087 114

PP 288
Golman, Walter, "Don't Let Your Slides Flip You: A Painless Guide to Visuals That Really Aid," 28 pp., Oct 1980, AD A092 732

PP 289
Robinson, Jack, "Adequate Classification Guidance - A Solution and a Problem," 7 pp., Aug 1980, AD A091 212

PP 290
Watson, Gregory H., "Evaluation of Computer Software in an Operational Environment," 17 pp., Aug 1980, AD A091 213

PP 291
Maddala, G. S.* and Trost, R. P., "Some Extensions of the Nerlove Press Model," 17 pp., Oct 1980, AD A091 946
*University of Florida

PP 292
Thomas, James A., Jr., "The Transport Properties of Binary Gas Mixtures in Applied Magnetic Fields," 10 pp., Sept 1980 (Published in Journal of Chemical Physics 72(10), 15 May 1980

PP 293
Thomas, James A., Jr., "Evaluation of Kinetic Theory Collision Integrals Using the Generalized Phase Shift Approach," 12 pp., Sept 1980 (Printed in Journal of Chemical Physics 72(10), 15 May 1980

PP 294
Roberts, Stephen S., "French Naval Policy Outside of Europe," 30 pp., Sept 1980 (Presented at the Conference of the Section on Military Studies, International Studies Association Kiawah Island, S.C.), AD A091 306

PP 295
Roberts, Stephen S., "An Indicator of Informal Empire: Patterns of U.S. Navy Cruising on Overseas Stations, 1869-1897," 40 pp., Sept 1980 (Presented at Fourth Naval History Symposium, US Naval Academy, 26 October 1979, AD A091 316

PP 296
Dismukes, Bradford and Petersen, Charles C., "Maritime Factors Affecting Iberian Security," (Factores Maritimos Que Afectan La Securidad Ibeica) 14 pp., Oct 1980, AD A092 733

PP 297 - Classified

PP 298
Mizrahi, Maurice M., "A Markov Approach to Large Missile Attacks," 31 pp., Jan 1981, AD A096,159

PP 299
Jondrow, James M. and Levy, Robert A., "Wage Leadership in Construction, 19 pp., Jan 1981, AD A094 797

PP 300
Jondrow, James and Schmidt, Peter,* "On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model," 11 pp., Jan 1981, AD A096 159
*Michigan State University

PP 301
Jondrow, James M.; Levy, Robert A. and Hughes, Claire, "Technical Change and Employment in Steel, Autos, Aluminum, and Iron Ore, 17 pp., Mar 1981, AD A099 394

PP 302
Jondrow, James M. and Levy, Robert A., "The Effect of Imports on Employment Under Rational Expectations," 19 pp., Apr 1981, AD A099 392

PP 303
Thomason, James, "The Rarest Commodity in the Coming Resource Wars," 3 pp., Aug 1981 (Published in the Washington Star, April 13, 1981)

PP 304
Duffy, Michael K.; Greenwood, Michael J.* and McDowell, John M.,** "A Cross-Sectional Model of Annual Interregional Migration and Employment Growth: Intertemporal Evidence of Structural Change, 1958-1975," 31 pp., Apr 1981, AD A099 393
*University of Colorado
**Arizona State University

PP 305
Nunn, Laura H., "An Introduction to the Literature of Search Theory," 32 pp., Jun 1981

PP 306
Anger, Thomas E., "What Good Are Warfare Models?" 7 pp., May 1981

PP 307
Thomason, James, "Dependence, Risk, and Vulnerability," 43 pp., Jun 1981

PP 308
Mizrahi, M.M., "Correspondence Rules and Path Integrals," Jul 1981. Published in "Nuovo Cimento B", Vol. 61 (1981)

PP 309
Weinland, Robert G., "An (The?) Explanation of the Soviet Invasion of Afghanistan," 44 pp., May 1981

PP 310
Stanford, Janette M. and Tai Te Wu,* "A Predictive Method for Determining Possible Three-dimensional Foldings of Immunoglobulin Backbones Around Antibody Combining Sites," 19 pp., Jun 1981 (Published in J. theor. Biol. (1981) 88, 421-439
*Northwestern University, Evanston, IL

PP 311
Bowes, Marianne, Brechling, Frank P. R., and Utgoff, Kathleen P. Classen, "An Evaluation of UI Funds," 13 pp., May 1981 (Published in National Commission on Unemployment Compensation's Unemployment Compensation: Studies and Research, Volume 2, July 1980)

PP 312
Jondrow, James; Bowes, Marianne and Levy, Robert, "The Optimum Speed Limit," 23 pp., May 1981

PP 313
Roberts, Stephen S., "The U.S. Navy in the 1980s," 36 pp., Jul 1981

PP 314
John, Christopher; Horowitz, Stanley A. and Lockman, Robert F., "Examining the Draft Debate," 20 pp., Jul 1981

PP 315
Buck, Ralph V., Capt., "Le Catastrophe by any other name...," 4 pp., Jul 1981

PP 316
Roberts, Stephen S., "Western European and NATO Navies, 1980," 20 pp., Aug 1981

PP 317
Roberts, Stephen S., "Superpower Naval Crisis Management in the Mediterranean," 35 pp., Aug 1981

PP 318
Vego, Milan N., "Yugoslavia and the Soviet Policy of Force in the Mediterranean Since 1961," 187 pp., Aug 1981

PP 319
Smith, Michael W., "Antiair Warfare Defense of Ships at Sea," 46 pp., Sep 1981 (This talk was delivered at the Naval Warfare System and Technology Conference of the American Institute of Aeronautics and Astronautics in Washington on December 12, 1980; in Boston on January 20, 1981; and in Los Angeles on June 12, 1981.)

PP 320
Trost, R.P.; Lurie, Philip and Berger, Edward, "A Note on Estimating Continuous Time Decision Models," 15 pp., Sep 1981

PP 321
Duffy, Michael K. and Ladman, Jerry R.,* "The Simultaneous Determination of Income and Employment in United States--Mexico Border Region Economies," 34 pp., Sep 1981
*Associate Professor of Economics, Arizona State University, Tempe, AZ.

PP 322
Warner, John T., "Issues in Navy Manpower Research and Policy: An Economist's Perspective," 66 pp., Dec 1981

PP 323
Bomse, Frederick M., "Generation of Correlated Log-Normal Sequences for the Simulation of Clutter Echoes," 33 pp., Dec 1981

PP 324
Horowitz, Stanley A., "Quantifying Seapower Readiness," 6 pp., Dec 1981 (Published in Defense Management Journal, Vol. 18, No. 2)

PP 327
Hammon, Colin, Capt., USN and Graham, David R., Dr., "Estimation and Analysis of Navy Shipbuilding Program Disruption Costs," 12 pp., Mar 1980

PP 328
Weinland, Robert G., "Northern Waters: Their Strategic Significance," 27 pp., Dec 1980

PP 330
Lockman, Robert F., "Alternative Approaches to Attrition Management," 30 pp., Jan 1982

PP 333
Lee, Lung-Fei and Trost, Robert P., "Estimation of Some Limited Dependent Variable Models with Application to Housing Demand," 26 pp., Jan 1982. Published in Journal of Econometrics 8 (1978) 357-382.

PP 334
Kenny, Lawrence W., Lee, Lung-Fei, Maddala, G.S., and Trost R.P., "Returns to College Education: An Investigation of Self-Selection Bias Based on the Project Talent Data," 15 pp., Jan 1982. Published in International Economic Review, Vol. 20, No. 3, October 1979.

PP 335
Lee, Lung-Fei, G.S. Maddala, and R.P. Trost, "Asymptotic Covariance Matrices of Two-Stage Probit and Two-Stage Tobit Methods for Simultaneous Equations Models with Selectivity," 13 pp., Jan 1982. Published in Econometrica, Vol. 48, No. 2 (March, 1980).

PP 336
O'Neill, Thomas, "Mobility Fuels for the Navy," 13 pp., Jan 1982. Accepted for publication in Naval Institute Proceedings.

PP 337
Warner, John T. and Goldberg, Matthew S., "The Influence of Non-Pecuniary Factors on Labor Supply," 23 pp., Dec 1981

PP 339
Wilson, Desmond P., "The Persian Gulf and the National Interest," 11 pp., Feb 1982

PP 340
Lurie, Philip, Trost, R.P., and Berger, Edward, "A Method for Analyzing Multiple Spell Duration Data," 34 pp., Feb 1982

PP 341
Trost, Robert P. and Vogel, Robert C., "Prediction with Pooled Cross-Section and Time-Series Data: Two Case Studies," 6 pp., Feb 1982

PP 342
Lee, Lung-Fei, Maddala, G.S., and Trost, R.P., "Testing for Structural Change by D-Methods in Switching Simultaneous Equations Models," 5 pp., Feb 1982

PP 343
Goldberg, Matthew S., "Projecting the Navy Enlisted Force Level," 9 pp., Feb 1982

DATE
FILMED

-8